A NOVEL APPROACH TO ONLINE PHYSICS REFRESHER COURSES AT POLITECNICO DI MILANO

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Abstract

Among the challenges that universities are facing nowadays, one that deserves special attention is the increasing number of dropouts. Refresher courses for perspective freshmen have regularly been organised at Politecnico di Milano over the last years as a means to tackle this issue. Due to the Covid-19 pandemic, the present situation posed serious limitations to traditional teaching methods this year, especially for long (3-4 hours) lectures which may be difficult to follow online.

In this paper we present a novel approach based on a blend of non-interactive conventional lectures in large groups and interactive lessons in smaller groups.

The course was delivered online using the Microsoft Teams software according to the following structure: first, a live video of a 1-hour lecture was streamed by a single tutor for the whole pool of approximately 1000 students. During this streaming, the students were not allowed to interact with the tutor or with one another by any means. Afterwards, 8 teams of students were formed and assigned to different tutors for the following three hours of more interactive lectures. Each tutor presented examples and exercises of their own choice (mainly on the same topic as the streamed video) and delivered guided solutions while promoting the interaction among students. Furthermore, a common set of short problems was given to each team: this activity could be performed at any time during the second part of the block, as decided by each tutor. In order to span among different teaching styles, the student teams were assigned to a different tutor every day for the interactive part of the lesson. As an additional resource, an online forum was activated on a dedicated website, which allowed students to ask questions on the course topics in an asynchronous way.

At the end of the course, every student was invited to fill in an anonymous survey to express their satisfaction with the course. The results of the survey indicate an overall degree of satisfaction with a mean rating over 75%.

Keywords: Physics; Refresher course; Remote teaching; Peer learning; Undergraduate students

1 INTRODUCTION

The problems of non-attendance and student dropout have been identified as critical in undergraduate studies for many years [1-5], leading a number of universities to implement different strategies to address these issues, including Massive Online Open Courses (MOOCs) and welcome sessions with refresher courses [6-9]. In the case of Science, Technology, Engineering and Mathematics (STEM) disciplines, these tools have also emerged as a means to assess and work on those misconceptions deriving from previous studies along with life experiences [10-11], which may hinder the learning process in the university years [12-16].

The experience of physics refresher courses at Politecnico di Milano over the past years has aimed at fighting these misconceptions by integrating MOOCs, conventional lectures and real-time quizzes taken in variably large classrooms [17].

Unfortunately, the Covid-19 outbreak and the following restrictions have made it impossible to organize live courses for large numbers of students in 2020. The need to deliver the physics refresher course online, however, led to problems connected to its original structure, since 3-4 hours of non-interactive lectures may be exceedingly long to follow online, especially for freshmen.

In order to overcome this problem while complying with the need to deliver the course fully online, a blended approach was developed, consisting of shorter synchronous streamed lectures and longer interactive lessons in smaller virtual groups.

A pool of approximately 1000 students enrolled in the course. Each day, the first part of the activities was common for the whole pool, while the second part was carried out in smaller subgroups. The first part was characterized by the impossibility for students to interact with the teacher or with one another. Conversely, the tutors in charge of the second activity promoted mutual interaction and peer learning. During each of these lessons, the students were also asked to take a short quiz, common to every subgroup.

Besides these synchronous activities, students were also encouraged to use a forum to discuss the subjects with one another or to ask the tutors for help in an asynchronous way. The streamed lectures which were delivered in the first part of each day were also made available on YouTube for asynchronous viewing.

The degree of satisfaction of the students was assessed at the end of the two weeks of course by a survey, which indicated mean appreciation rates above 75% for each of the activity and for the whole course as well.

2 METHODOLOGY

The physics refresher course was delivered in September 2020 to a pool of 976 students enrolled as freshmen in the Engineering courses of Politecnico di Milano. Approximately 50% of the students had attended a scientific senior secondary school (Liceo Scientifico), the other half had graduated at technical schools or other types of senior secondary schools. All the synchronous parts of the course were delivered in remote using the Microsoft Teams software. The activities were organized in eight blocks (approximately 4 hours each) distributed over two weeks. The teaching staff included a course coordinator (in charge of organizing the activities and welcoming the students), a leading tutor (in charge of live streaming lectures for the whole pool of students) and nine tutors (working with smaller student groups as detailed below).

Each of the 8 blocks was dedicated to a broad area of physics (e.g. Kinematics, Thermodynamics, Static electricity etc.) and organized according to the scheme detailed in Table 1.

Table 1. Scheme of the activities of each module

Activity	Teacher	Number of students	Duration	Interacting
Streamed lecture	Leading tutor	976	1 h	No
Group lessons	Tutors (one for each group, changing every day)	122 per group	2-3 h	Yes
Group quizzes	Tutors (one for each group, same as group lesson)		15-20 min	No
Forum	Tutor (one for all students, changing every day)	976	Asynchronous	Yes

Every subject was introduced by a 1-hour live streamed lecture given by the leading tutor. All the students were connected to Microsoft Teams and followed the lecture simultaneously, without the possibility to interact with the teacher or with one another. This lecture was also made available for later viewing on YouTube.

After this live streaming, the students were divided into eight virtual Microsoft Teams rooms and assigned to a different tutor every day for the second part. With a duration of 2-3 hours, this was the longest activity of each module and its structure was devised by each tutor quite freely, with only three staples. First, tutors should pick examples, problems and exercises of their choice pertaining to the subject introduced in the live lecture. Second, tutors were to promote interaction among students and to encourage question posing. Third, a group quiz on the subject had to be delivered at any time during the lesson. The quizzes were common to all subgroups, included short problems without exceedingly long calculations, and needed to be answered on dedicated Google Forms by each student. Tutors could choose to deliver the quiz at the beginning, midway or at the end of the group activity at their ease, leaving an approximate time of 15-20 minutes for the individual solution and a generally longer time to discuss the answers. During the discussion phase, tutors were asked to stimulate student interaction as much as possible.

Finally, a forum was made available for students to interact with teachers or to create discussions concerning the course topics. A different tutor was assigned to forum monitoring every day.

This whole structure was repeated for eight days: the leading tutor who gave the live lecture was always the same person, while the student group/tutor pairing for the interactive lessons was changed every day.

At the end of the course, students were asked to fill out an evaluation survey, with questions about each activity and about the overall satisfaction with the physics refresher course. The survey was developed with multiple choice answers, which were assigned a numerical value for quantitative analysis (1 = Not satisfied; 2 = A little satisfied; 3 = Quite satisfied; 4 = Very much satisfied). Students also had the possibility to point out the positive and negative aspects of the course and of its parts in dedicated text fields.

3 RESULTS

3.1 Attendance

Out of 976 students enrolled in the course, approximately 65% attended the live streamed lectures. A comparable number of views has been counted on the YouTube videos, which however cannot be ascribed to students only since the videos are publicly available. The number of students in each subgroup was 122, with an approximate attendance rate of 80% for interactive lessons. During the two weeks of activities, the attendance rate exhibited a slight decrease, both for live lectures and group lessons.

Interestingly, the employment of the forum was negligible with respect to course attendance. In fact, over two weeks, only two active topics were created with one question each.

3.2 Evaluation survey

The evaluation survey was filled out by 159 students in the days following the end of the course. 68% of the interviewed sample claimed to have attended most of the modules, 23% about half, 13% claimed to have enrolled without attending.

The multiple-choice part of the survey was detailed as follows: the first question asked the students to rate their satisfaction with the streamed lecture delivered at the beginning of each module. The rating could be expressed both for the live streaming and for the asynchronous YouTube viewing. The second question assessed the interactive lessons in subgroups with different tutors, whereas the third question inquired about the quizzes delivered by the tutors. Finally, students were asked to express their overall satisfaction with the course. The results of the survey are reported in Table 2.

Table 2. Results of the evaluation survey

	Number of Answers	Mean score	Standard deviation
Streamed lecture (live)	143	3.196/4	0.674
Streamed lecture (YouTube)	94	3.128/4	0.833
Group activities in the second part	140	3.150/4	0.813

Quizzes	134	3.045/4	0.839
Overall satisfaction	146	3.021/4	0.669

The results show that a larger group of the interviewed sample followed the first part of the lecture live rather than on YouTube, in either case expressing a satisfaction degree between 78% and 80%. The interactive lessons with tutors were appreciated by approximately 79% of the students, and the percentage of satisfactions decreases to 76% when it comes to quizzes. However, the data concerning asynchronous viewing, interactive lessons and quizzes are more broadly scattered. The overall satisfaction with the course was approximately 75%, with a smaller standard deviation than the previous questions.

The positive aspects pointed out by the students were mostly in the form of general considerations (students mentioned the "usefulness" of a refresher course and the "competence" of tutors, a few pointed out the advantage of having the recorded lecture available for later viewing). Concerning the negative aspects, the most cited was the rotation of tutors over the eight modules: over 30% of the students who decided to mention a negative aspect of the course referred to this choice as a drawback.

4 CONCLUSIONS

A physics refresher course in a fully virtual format was organized at Politecnico di Milano, in order to facilitate the study course of students, address their misconceptions while complying with social distancing rules dictated by the Covid-19 pandemic.

The course, attended by approximately 1000 students, was characterized by a blend of non-interactive streamed lectures and interactive group activities, thus spanning over different teaching methods and class sizes. The first part was common to all students and delivered in the form of a traditional lecture, while the second part was carried out in smaller groups and it featured guided examples, class discussion and online quizzes.

At the end of the course, an evaluation survey filled out by the students indicated a degree of satisfaction over 75% for each of the course activities, as well as for the whole course.

These results indicate that this approach is promising and can be repeated in the future, while the overall efficacy of the course in terms of avoiding student dropout and increasing their performance will be the subject of future analysis as the students progress in their studies.

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